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A STUDY ON LEAD-LAG RELATIONSHIP BETWEEN FUTURES AND SPOT MARKETS IN CASE OF AGRICULTURAL COMMODITY DERIVATIVES IN INDIA

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ABSTRACT

The two major economic functions of a commodity futures market are price risk management and price discovery. The effectiveness of the price risk management depends on how efficiently the futures market fulfills the price discovery function. The main objective of this study is to examine the lead-lag relationship between the futures and spot markets in case of select agricultural commodity derivatives traded in India. National Commodity and Derivatives Exchange Limited (NCDEX) being the largest agricultural commodity futures trading platform was purposively selected among all the National Commodity Exchanges functioning in the country. The sampling design used for the study is proportionate sampling which consists of five agricultural commodity derivatives viz. refined soya oil, guar seed, chana, soya bean and castor seed which were traded on the NCDEX platform. The study was purely based on secondary data which was drawn from the official website of NCDEX. The data comprised of daily closing spot prices and futures prices with near month (expiration month) maturity pertaining to the sample agricultural commodity derivatives traded on the exchange. The period of study was from January 2004 to November 2016. The lead-lag relationship between futures and spot prices of the sample agricultural commodity derivatives has been examined using VECM and Granger Causality test. In the long run, futures return was leading the spot return in case refined soya oil and chana. Similarly spot return was leading the futures return in case of soya bean and castor seed. In the short run, futures return was leading spot return in case of guar seed and spot return was leading futures return in case of castor seed. There was a bidirectional causality found in case of refined soya oil, chana and soya bean.

***KEYWORDS:** Lead-Lag Relationship, Price Discovery, NCDEX, VECM & Granger Causality Test*

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INTRODUCTION

Commodity derivatives made their appearance before financial derivatives in the world and also in India. Informal trading in commodity derivatives was practiced in ancient India, but the formal took shape in the late nineteenth century. The growth path of the Indian derivative market was not smooth. Trading remained banned for a long period of time since 1966 and it was reintroduced in the early 2000s. The first modern futures market was established in 1875 for cotton contracts by the Bombay Cotton Trade Association. Oilseed and food grain futures followed and before the World War II, futures were being traded on commodities such as wheat, rice, sugar, groundnut, groundnut oil, raw jute, jute products and castor seed as well as precious metals. After independence,

the Forward Contracts (Regulation) Act was enacted in 1952 to regulate the trading in forward and futures. The Forward Markets Commission (FMC) which oversees forward trading was instituted as a regulatory body the following year. In 1966, futures trade was altogether banned to give effective powers to government price control. A few select commodities saw a reintroduction of futures in 1980 following the Khusro Committee report. But the real breakthrough came with the liberalization of the Indian economy in the early 1990's. In 1993, the Kabra Committee was appointed to look into forward markets. The committee recommended in 1994 that all futures banned in 1966 be reintroduced as well as many others added. Six years later, the National Agricultural Policy 2000 envisioned the removal of price controls in agricultural markets and widespread use of futures contracts. However, the commodity futures market made the true restart in early 2000's with establishment of a number of nationwide multi commodity exchanges (Gupta, 2011).

In the Union Budget for FY 2015-16, the Honorable Union Finance Minister proposed merger of Forward Markets Commission (FMC) with the Securities and Exchange Board of India (SEBI). FMC was merged with SEBI on September 28, 2015 and the Securities Contracts (Regulation) Act, 1956 was amended to include commodity derivatives within the definition of securities and Forward Contracts (Regulation) Act, 1952 (FCRA) was repealed. A total of 113 commodities have been permitted for trading in the commodities futures market, 38 commodities were actively traded at these exchanges, of which 28 were agricultural commodities and 10 were non-agricultural commodities. Among the agricultural commodities which were traded at the National Commodity Exchanges, National Commodity and Derivatives Exchange of India (NCDEX) traded 18, Multi Commodity Exchange of India (MCX) traded 5 and National Multi Commodity Exchange (NMCE) traded 6 during 2015-16 (SEBI, 2016).

Price Discovery in Commodity Futures Market

The two major economic functions of a commodity futures market are price risk management (hedging) and price discovery. A futures exchange carries out these twin functions by providing a trading platform that brings buyers and sellers together. The hedging is used to manage price risks. It allows transfer of price risk to other agents who are willing to bear such risks. The hedgers, in principle, buy futures contracts for protection against rising commodity prices and sell futures for protection against falling prices or to get a guaranteed price in the future. It is important to note that the commodity futures price, the price agreed upon by the parties for the future transaction, is a market estimate about the future price of the underlying commodity. It reflects the price expectations of both buyers and sellers for a time of delivery in the future. It may be higher or lower than the spot price of the commodity in the spot market. Thus, the futures price could be used as an estimate of the spot price of a commodity at some future date.

However, futures prices keep changing until the last date of the futures contract subject to additional information about demand and supply. The continuous flow of information makes the process of price discovery dynamic in a commodity futures market. For instance, the price of March futures contract of any agricultural commodity will reflect the opinions of buyers and sellers about the value of that commodity when the contract expires in March. The March futures prices may go up or down with the availability of new information. The price signal can provide a direction to a farmer about what a commodity will be worth at a future point of time and, on the basis of future prices, he can take decisions on what to produce (i.e, choice among different crops to be grown in a season) on the likely prices in the near future. Hence, the farmers can benefit from the dissemination of the futures prices (Mahajan and Singh, 2015).

The effectiveness of the price risk management depends on how efficiently the futures market fulfills the price discovery objective. Price discovery is the process of new information being factored into the prices (Kumar and Shollapur,

2015). The price discovery benefit of futures trading is predicted on the assumption that future prices reflect the combined views of a large number of buyers and sellers, all expressing their perceptions of the future value of some commodity (Fortenbery and Zapata, 1997). The price discovery process is ascertained by analyzing the lead-lag relationship between the futures and the spot market. This study is significant because it helps to determine which market is more efficient in processing and disseminating new information (Vasantha and Mallikarjunappa, 2015). The lead-lag relationship investigates whether the spot market leads the futures market, whether the futures market leads the spot market or whether the bi-directional feedback between the two markets exists. It also illustrates how well the two markets are linked, and how fast one market reflects new information from the other (Floros and Vougas, 2007).

Some of researchers in India have examined the price discovery and lead-lag relationship between the futures and spot markets pertaining to agricultural commodity derivatives. Sehgal et.al. (2012) concluded that, futures market was playing the lead role in price discovery in case of majority of the sample commodities except turmeric. Basavaraj and Chowdri (2013) concluded that futures market for red chilli in India was leading the spot market in impounding future expectations about the future spot price. Sharma (2015) concluded that futures were leading the spot in case of soya bean and soya oil, whereas in case of chana and pepper bi-directional relationship was found. The existing literature on price discovery in the Indian commodity futures market has covered mainly non-agri commodities like precious metals, energy products etc. and the literature pertaining to agricultural commodity derivatives is very limited. The number of agricultural commodities covered in these studies are also very less and the time frame used for the analysis is also very short so as to come out with a meaningful inference. Hence there is lot of scope for doing research in the area of agricultural commodity derivatives.

The main objective of the present study is to examine the lead-lag relationship between the futures and spot markets in case of select agricultural commodity derivatives traded in India. This study is significant because in case of competitive price discovery all the available market information is continuously transmitted into futures price, providing an indicator of supply and demand. The benefits of future markets extend not only to the participants, but also for other farmers and traders who are not involved in future trading directly, who use futures prices for the purpose of production and process decisions.

MATERIALS AND METHODS

Sampling

Proportionate sampling technique has been followed to select the commodity exchange as well as the agricultural commodity derivatives used for the present study. Among the three National Commodity Exchanges, National Commodity and Derivatives Exchange Limited (NCDEX) is the largest agricultural commodity futures trading platform (Jha, 2015) which is also clearly evident from the Table 1, was selected. As of March 31st 2015, the Exchange offered trading in 26 commodities, which included 21 agricultural commodities, 2 bullion commodities, 2 metals and 1 commodity in energy and polymer sector. This showed the dominance of agricultural commodity derivatives in the exchange in comparison with non-agri commodity derivatives.

Table 1: Average Share of Agricultural Commodity Derivatives Traded in Major National Commodity Exchanges from 2010-11 to 2015-16

Sl. No.	Exchange	Volume (Lakh Tonnes)	Share of Volume (Per Cent)	Value (Crores)	Share of Value (Per Cent)
1	NCDEX	3,356.99	85.64	13,92,875.45	74.70
2	MCX	372.17	9.49	3,67,344.67	19.70
3	NMCE	190.68	4.86	1,04,491.40	5.60
	Total	3,919.84	100	18,64,711.52	100

Source: FMC Annual reports (2010-11 to 2013-14) and SEBI Annual report (2015-16)

Five agricultural commodity derivatives viz. refined soya oil, guar seed, chana, soya bean and castor seed were proportionately selected based on the value/volume traded at NCDEX. These commodity derivatives were selected based on their high value as well as trading volume and were consistently performing well on the NCDEX platform for many years which is clearly evident from the Table 2 and hence they formed a formidable base for the analysis.

Table 2: Average Trading Volume and Value of the Agricultural Commodity Derivatives Traded on NCDEX from 2009-10 to 2013-14

Sl. No.	Commodity	Volume (Lakh Tonnes)	Share of volume (Per Cent)	Value (Crores)	Share of Value (Per Cent)
1	Ref. Soya oil	505.722	15.03	328058.55	24.84
2	Guar seed	568.406	16.89	165486.85	12.53
3	Chana	511.153	15.19	157219.17	11.90
4	Soya bean	498.453	14.81	144707.51	10.96
5	Castor seed	129.714	3.85	50979.42	3.86
6	Other agri	1,151.8007	34.23	474315.44	35.91
	Total	**3,365.251**	**100**	**1320766.94**	**100**

Source: FMC Annual reports (2009-10 to 2013-14)

Data Collection

The study was purely based on secondary data which was drawn from the official website of NCDEX. The data comprised of daily closing spot prices and futures prices with near month (expiration month) maturity pertaining to the sample agricultural commodity derivatives traded on the exchange. The near month futures contracts were selected for the analysis as they are considered as highly liquid and the most active contracts. The data on trading volume and open interest for the sample agricultural commodity derivatives was also collected on daily basis.

The period of study was from January 2004 to November 2016; however the data points varied across the commodity derivatives owing to their late introduction on the commodity exchange and the fact that some commodity derivatives were banned for certain period in order to curb the speculative impacts which according to policy makers could have triggered inflation. Another reason for the variation is attributed to the availability of the futures and spot price data on the NCDEX website during the time of data collection. The list of sample commodities and their respective data points as well as reference market for spot price is given in the following Table 3.

Table 3: Data Points for the Sample Agricultural Commodity Derivatives

Sl. No.	Commodity	Data Points	Futures Price	Spot Price
1	Refined soya oil	January 2004 – September 2016	NCDEX	Indore
2	Guar seed	June 2004 – November 2016	NCDEX	Jodhpur
3	Chana	June 2004 – July	NCDEX	Delhi

		2016		
4	Soya bean	January 2004 – October 2016	NCDEX	Indore
5	Castor seed	October 2004 – January 2016	NCDEX	Deesa

Source: www. ncdex.com

Tools of Analysis

Time series data pertaining to the sample agricultural commodity derivatives was analyzed using various statistical and econometric tools. The base data of spot and futures prices was converted into continuous daily return series by taking natural logarithm. Natural logarithm of daily prices was taken to minimize the heteroscedasticity in data (Sehgal et.al, 2012). The rate of return for each day is defined as the difference between the natural log of a particular day's price and the natural log of the previous day's price.

$R_t = [\ln(P_t) - \ln(P_{t-1})]$,

Where, R_t is the return for the day t, ln is the natural log, P_t and P_{t-1} are the closing prices for day 't' and its previous trading day. However the base data of spot and futures prices was also used at appropriate stages of the analysis. The data was analyzed using MS Excel 2007 and Eviews-9 econometric software package.

The lead-lag relationship between futures and spot prices of the sample agricultural commodity derivatives is examined using the following econometric tools:

Augmented Dickey-Fuller Test (Pre-Test for Stationarity)

The price series are subjected to Augmented Dickey-Fuller test (ADF test) to check for the presence of unit root both at the level as well as the first difference. This is done to make sure that the data is integrated at first difference [I (1)] and hence does not exhibit unit root property (Kumar and Shollapur, 2015).

Johansen's Cointegration Test

The nature of long-run equilibrium relationship between the spot and futures market for the sample agricultural commodity derivatives is ascertained using Johansen's Cointegration test. In practice many financial variables contain unit root and are thus said to be integrated at first difference [I (1)]. The cointegration test is based on maximum likelihood estimation and uses two test statistics, namely trace statistics (λ_{trace}) and maximum Eigen value statistics (λ_{max}) to determine the number of co integrating vectors (Johansen and Juselius, 1990).

Vector Error Correction Model (VECM)

Once the long-term equilibrium relationship is established through co integration, it is necessary to understand the long run price discovery role and short term price dynamics (Kumar and Shollapur, 2015). If the price series are not stationary, then the Vector Auto Regression (VAR) framework needs to be modified to allow consistent estimation of the relationships among them. Hence VECM is just a special case of VAR for the variables that are stationary in their first differences [I (1)].

Granger (1986) states that if two variables are [I (1)] and co integrated, there must be causality in at least one direction. Bidirectional causality is also possible. This is due to the error correction mechanism between the two series that keeps bringing them back to equilibrium at regular intervals (Kumar and Shollapur, 2015). Besides, Ghosh (1993), Lien

and Luo (1994) and Lien (1996) argued that if the two price series are found to be cointegrated, then there exist valid error correction representations of the price series that includes short-term dynamics and long run information (Srinivasan, 2012).

Hence, the causality between futures and spot returns is estimated by using the following VECM:

$$\Delta F_t = \alpha_f + \lambda_f e_{t-1} + \sum_{i=1}^{r} \gamma_{f,i} \Delta f_{t-i} + \sum_{i=1}^{r} \omega_{s,i} \Delta s_{t-I} + \varepsilon_{ft} \quad (1)$$

$$\Delta S_t = \alpha_s + \lambda_s e_{t-1} + \sum_{i=1}^{r} \gamma_{s,i} \Delta s_{t-i} + \sum_{i=1}^{r} \omega_{f,i} \Delta f_{t-i} + \varepsilon_{st} \quad (2)$$

Where, ΔF_t : Vector of log futures price (futures returns), ΔS_t : Vector of log spot price (spot returns), α_f and α_s : Intercepts, λ_f and λ_s : Coefficients of long-term error correction terms/speed of adjustment parameters, e_{t-1} : Error correction term, $\gamma_{f,i}$ and $\gamma_{s,i}$: Short term coefficients, $\omega_{s,i}$ and $\omega_{f,i}$: Short term coefficients, ε_{ft} and ε_{st} : White noise disturbance terms

In the equations (1) and (2), the error correction term (e_{t-1}) measures how the dependent variable adjusts to the previous period's deviation from long run equilibrium. Speed of adjustment parameters or coefficients of long term error correction terms (λ_f and λ_s) establish the long run equilibrium relationship. As λ_f increases, the response of F_t to the previous period's deviation from long run equilibrium also increases. The short term coefficients ($\gamma_{f,i}, \gamma_{s,i}, \omega_{s,i}$ and $\omega_{f,i}$) represent the short run influence of the returns of one market on the returns of the other. The lag length for VECM is selected based on Schwarz Information Criteria (SIC). After estimating Equations (1) and (2), Wald F-test is conducted on the coefficients to check whether they are jointly significant.

Granger Causality Test

After the pre-requisite testing of the stationarity is done, the widely accepted Granger Causality test is deployed to detect the direction of relationship or causation between two variables (Granger, 1969). If the time series are cointegrated, then the aforesaid VECM can be used to determine the short run deviation from the long run equilibrium, otherwise Granger Causality can be employed to navigate the direction of causation (Brahmasrene and Jiranyakul, 2007). This test is considered to be a very strong test against unit roots and is a classic choice in econometric literature whenever two series are of the order [I (0)] (Foresti, 2007).

The test involves estimating the following simple Vector Auto Regressions (VAR):

$$F_t = \alpha + \sum_{i=1}^{p} a_i F_{t-i} + \sum_{j=1}^{q} b_j S_{t-j} + \varepsilon_t \quad (3)$$

$$S_t = \beta + \sum_{i=1}^{r} c_i S_{t-i} + \sum_{j=1}^{s} d_j F_{t-j} + \eta_t \quad (4)$$

Where, F_t : Futures return at time 't', S_t : Spot return at time 't', α *and* β : Intercepts, a_i *and* b_j : Coefficients on the lagged F and S values respectively, c_i *and* d_j : Coefficients on the lagged S and F values respectively, *i and j* : Number of lags ε_t and η_t : Error term

If the coefficient b_j's are statistically significant but d_j's are not, then spot return (S) Granger causes futures return (F). Similarly in the reverse case futures return (F) Granger causes spot return (S). But in case, if both b_j's and d_j's are found to be statistically significant, then the causality is bidirectional.

RESULTS

Pre-Test for Stationarity

The time series stationarity was tested for the select agricultural commodity derivatives viz. refined soya oil, guar

seed, chana, soya bean and castor seed using Augmented Dickey Fuller test (ADF). The futures and spot price series were tested for the presence of unit root at the base level as well as at the first difference level. It could be observed from the estimated results that both futures and spot price series in case of refined soya oil, chana, and soya bean and castor seed were exhibiting the presence of unit root when tested using their level data. The same estimation procedure was conducted for both the price series at their first difference and it could be observed that there was no unit root in the data. Therefore the price series at first difference was found to be stationary in both the futures and spot markets for refined soya oil, chana, and soya bean and castor seed. Since the two price series were [I (1)] or integrated at first difference, it was possible to test for the cointegrating relationship using Johansen's Cointegration test. However the case was not the same in case of futures and spot price series of guar seed as they were found to be stationary when tested using their level data itself. As a result it didn't qualify for Johansen's Cointegration test which also confirmed that there wasn't any long run equilibrium relationship present between the two price series of guar seed. The detailed results of the ADF test are presented in the Annexure 1.

Johansen's Cointegration Test

The presence of cointegrating relationship between the futures and spot price series of refined soya oil, chana, soya bean and castor seed was tested using Johansen's Cointegration test and the results are presented in the Table 4. The test was conducted for the existence of number of hypothesized cointegrating equations. It could be inferred that the futures and spot price series for refined soya oil, chana, soya bean and castor seed were cointegrated and exhibiting a long run equilibrium relationship. The presence of cointegrating relationship also confirmed that there was a causal relationship between the futures and spot price series, at least in one direction.

Table 4: Johansen's Cointegration Test Results

Commodity	Hypothesized No. of Cointegrating Equations	Trace Test		Max. Eigen Value		*p*-value#	Lags
		Statistics	Critical Values	Statistics	Critical Values		
Refined Soya Oil	None	155.80	15.49	153.52	14.26	0.00*	4
	At most 1	2.28	3.84	2.28	3.84	0.13	
Chana	None	115.74	25.87	109.73	19.39	0.00*	4
	At most 1	6.01	12.52	6.01	12.52	0.46	
Soya bean	None	112.49	15.49	110.21	14.26	0.00*	2
	At most 1	2.28	3.84	2.28	3.84	0.13	
Castor seed	None	103.56	15.49	102.14	14.26	0.00*	4
	At most 1	1.42	3.84	1.42	3.84	0.23	

Note: *denotes rejection of null hypothesis (H_0) at 5 per cent level of significance. # MacKinnon-Haug-Michelis (1999) p-values

Vector Error Correction Model

The presence of lead-lag relationship between the futures and spot return series of refined soya oil, chana, soya bean and castor seed was tested using Vector Error Correction Model (VECM) and the results are presented in the Table 5. The coefficients of VECM were estimated in case of panel 1 wherein futures return was taken as dependent variable and spot return as explanatory variable. Similarly in case of panel 2, spot return was taken as dependent variable and futures return as explanatory variable. The lag length of 2 was selected on the basis on Schwarz Information Criteria (SIC). It could be observed that both the error correction coefficients λ_f and λ_s were found to be negative and statistically significant

in case of all the aforesaid commodities. This suggested a long term bidirectional causality in futures and spot return series of all these commodities which meant that whenever these cointegrated series were to be in disequilibrium in the short run, both the futures and spot return series would adjust in order to re-establish the equilibrium. This finding was also in line with the cointegration test's inference, that there must be a long term causal relationship in at least one direction. However, the error correction term in the spot return equation was found to be greater in magnitude than that of futures return equation in case of refined soya oil and chana. In other words, futures return was leading the spot return in case of price discovery in the long run. On the other hand, spot return was leading the futures return in case of price discovery in the long run in case of soya bean and castor seed.

The short run causality was captured by the short term coefficients ω_{s1}, ω_{s2}, ω_{f1} and ω_{f2}. Here the spot returns with 2 lags were seen influencing the futures return which could be observed from the statistical significance of spot return on futures return both at one and two lags in case of refined soya oil, chana and soya bean. Similarly futures return with 2 lags was seen influencing the spot return which could be observed from the statistical significance of futures return on spot return at both one and two lags in case of the aforesaid commodities. Further the joint significance of all the short term coefficients was tested using Wald F test. The presence of bi-directional causality in the short run was confirmed by the statistical significance of the Wald F statistic in both panel 1 and panel 2 respectively. Therefore there existed a bi-directional lead-lag relationship between the futures and spot returns of refined soya oil, chana and soya bean in the short run. However in case of castor seed the spot returns with 2 lags were seen influencing the futures return which could be observed from the statistical significance of spot return on futures return both at one and two lags. On the contrary, there was no short term causality flowing from futures to spot as there was no statistical significance found both at one and two lags. Further the unidirectional causality from spot to futures was confirmed by the statistical significance of the Wald F statistic in panel 1 and hence it could be inferred that in short term spot return of castor seed was leading the futures return.

Granger Causality Test

As there was no long run equilibrium relationship between the two price series in case of guar seed, the futures and spot return series were tested for the presence of short term causality using Granger Causality test and the results are presented in the Table 6. Spot return does not granger-cause futures return and futures return does not granger-cause spot return were the formulated null hypothesis. At lag 2, the null hypothesis of futures return does not granger-cause spot return was rejected at 5 per cent level of significance and the alternative hypothesis being futures return granger-cause spot return was accepted. Hence there was a short term unidirectional causality flowing from futures market to spot market of guar seed and therefore it could be inferred that futures return was leading the spot return in the short run.

The results of the lead-lag relationship obtained from all the sample agricultural commodity derivatives explained the role of futures market as well as spot markets in price discovery mechanism. In the long run, futures return was leading the spot return in case refined soya oil and chana. These results were similar to the findings of the study conducted by Vasantha and Mallikarjunappa (2015), Kumar and Shollapur (2015). Similarly spot return was leading the futures return in case of soya bean and castor seed. These results were similar to the findings of the study conducted by Srinivasan (2012) and Prasanna (2014). In the short run, futures return was leading spot return in case of guar seed and spot return was leading futures return in case of castor seed. There was a bidirectional causality found in case of refined soya oil, chana and soya bean. Overall futures market in case of refined soya oil, guar seed and chana was successful in achieving its intended primary objective of price discovery. The main reason behind this leading role of the futures market in case of these

commodities was the more number of market participants which was reflected in the trading volume as well as value over the years (Table 2). But in case of soya bean and castor seed spot market was found to be leading the futures market and the reasons were obvious that there were comparatively less number of market participants which was reflected in the trading volume as well as value over the years and also the lack of awareness among the participants about the futures market. These findings could help the market participants dealing in the agricultural commodity derivatives (farmers, traders etc.) to hedge their price risk by taking appropriate positions in the market.

In case of refined soya, guar seed and chana futures market price could be considered as a base price by the hedgers and similarly spot market price could be used in case of soya bean and castor seed.

Table 5: Estimates of Vector Error Correction Model

Commodity	Coefficient	Panel 1: Futures Return (Dependent variable)			Coefficient	Panel 2: Spot Return (Dependent variable)		
		Value	S.E.	t-statistic		Value	S.E.	t-statistic
Refined Soya Oil	λ_f	-0.80	0.06	-13.25*	λ_s	-0.74	0.05	-15.92*
	γ_{f1}	-0.06	0.05	-1.18	γ_{s1}	-0.22	0.04	-6.23*
	γ_{f2}	-0.01	0.03	-0.26	γ_{s2}	-0.16	0.02	-7.12*
	ω_{s1}	-0.55	0.05	-10.85*	ω_{f1}	-0.22	0.03	-6.59*
	ω_{s2}	-0.32	0.03	-10.34*	ω_{f2}	-0.07	0.02	-3.30*
	ε_{ft}	0.00	0.00	0.01	ε_{st}	0.00	0.00	0.04
	Wald *F*-Statistic			67.82*	**Wald *F*-Statistic**			27.45*
Chana	λ_f	-0.48	0.04	-11.12*	λ_s	-1.02	0.04	-27.25*
	γ_{f1}	-0.29	0.04	-7.68*	γ_{s1}	-0.05	0.03	-1.67
	γ_{f2}	-0.18	0.02	-7.17*	γ_{s2}	-0.04	0.02	-2.70*
	ω_{s1}	-0.39	0.04	-9.37*	ω_{f1}	-0.19	0.03	-7.28*
	ω_{s2}	-0.24	0.02	-10.07*	ω_{f2}	-0.12	0.02	-7.08*
	ε_{ft}	0.00	0.00	-0.03	ε_{st}	0.00	0.00	-0.03
	Wald *F*-Statistic			55.70*	**Wald *F*-Statistic**			29.64*
Soya bean	λ_f	-0.96	0.05	-20.72*	λ_s	-0.57	0.03	-17.48*
	γ_{f1}	0.03	0.04	0.70	γ_{s1}	-0.26	0.03	-9.85*
	γ_{f2}	-0.02	0.02	-0.76	γ_{s2}	-0.16	0.02	-9.39*
	ω_{s1}	-0.54	0.04	-14.27*	ω_{f1}	-0.13	0.03	-5.17*
	ω_{s2}	-0.29	0.02	-11.73*	ω_{f2}	-0.07	0.02	-4.23*
	ε_{ft}	0.00	0.00	-0.02	ε_{st}	0.00	0.00	0.99
	Wald *F*-Statistic			110.06*	**Wald *F*-Statistic**			13.38*
Castor seed	λ_f	-0.99	0.13	-7.83*	λ_s	-0.48	0.12	-3.95*
	γ_{f1}	0.12	0.10	1.26	γ_{s1}	-0.59	0.09	-6.22*
	γ_{f2}	0.09	0.06	1.47	γ_{s2}	-0.35	0.06	-5.98*
	ω_{s1}	-0.77	0.10	-7.79*	ω_{f1}	-0.05	0.09	-0.50
	ω_{s2}	-0.41	0.06	-6.67*	ω_{f2}	0.04	0.06	0.62
	ε_{ft}	0.00	0.00	-0.06	ε_{st}	0.00	0.00	-0.04
	Wald *F*-Statistic			30.87*	**Wald *F*-Statistic**			1.49

Note: * denotes significance at 5 per cent level; S.E: Standard Error

Table 6: Granger Causality Test Result for the Futures and Spot Returns of Guar Seed

Null Hypothesis	F-Statistic	*p*-value	Direction of Causality	Lags
Spot return does not Granger-Cause futures return	2.40	0.09	Unidirectional: Futures Return Granger-Causes Spot Return	2
Futures Return Does Not Granger-Cause spot return	159.51	0.00*		

Note: *denotes rejection of null hypothesis (H_0) at 5 per cent level of significance. # MacKinnon-Haug-Michelis (1999) p-values

CONCLUSIONS

In the present study, the lead-lag relationship between the futures and spot markets in case of select agricultural commodity derivatives traded at NCDEX has been analyzed. The commodity derivatives viz. refined soya oil, guar seed, chana, soya bean and castor seed form the major chunk of the agricultural commodities traded at NCDEX both in terms of value as well as volume. Hence the price discovery mechanism between the futures and spot prices will be keenly observed by the participants who would like to hedge their spot price risk using the futures contracts of these agricultural commodities. In case of refined soya oil and chana, futures market was found to be leading the spot market in long run. On the other hand, the long-run causality has been flowing from spot market to futures market in case of soya bean and castor seed. The existence of a bidirectional lead-lag relationship in the short run was confirmed in case of refined soya oil, chana and soya bean. Castor seed encountered unidirectional causality from spot to futures and hence spot market of castor seed was leading the futures market in the short run. Similarly guar seed also encountered unidirectional causality, but here futures market was found to be leading the spot market in the short run. Apart from helping the hedgers dealing in the futures contracts of select agricultural commodity derivatives, the results of this study also provides vital inputs to policy makers as well as to the futures market regulator SEBI. As the price discovery mechanism becomes more efficient, the hedgers dealing in agricultural commodities will start to reap more benefits and hence this has the potential to attract more farmers towards futures trading. This combo of risk reduction and assured profit will be an alluring factor which could bring the farming community and futures market on a single platform. Even though the commodity futures market in India have been performing well off late in the process of price discovery, but still there is a lot of scope to improve in terms of their efficiency which can be done by keeping the speculators in check.

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APPENDICES

Annexure 1: Stationarity Test Results

Commodity	Price Series		ADF Test Statistics L.	ADF Test Statistics F.D.	Critical Value at 5 Per cent	p-value# L.	p-value# F.D.	Order of Integration
Refined Soya Oil	Futures	None	0.15	-55.66*	-1.94	0.73	0.00*	I(1)
		Intercept	-1.56	-55.66*	-2.86	0.50	0.00*	
		Intercept & Trend	-2.71	-55.65*	-3.41	0.23	0.00*	
	Spot	None	0.25	-45.29*	-1.94	0.76	0.00*	I(1)
		Intercept	-1.41	-45.29*	-2.86	0.58	0.00*	
		Intercept & Trend	-2.51	-45.28*	-3.41	0.32	0.00*	
Chana	Futures	None	2.43	-52.85*	-1.94	0.99	0.00*	I(1)
		Intercept	1.80	-52.90*	-2.86	0.99	0.00*	
		Intercept & Trend	0.48	-52.96*	-3.41	0.99	0.00*	
	Spot	None	2.74	-52.62*	-1.94	0.99	0.00*	I(1)
		Intercept	2.19	-52.69*	-2.86	1.00	0.00*	
		Intercept & Trend	0.90	-52.76*	-3.41	0.99	0.00*	
Soya bean	Futures	None	-0.03	-56.70*	-1.94	0.67	0.00*	I(1)
		Intercept	-1.50	-56.70*	-2.86	0.53	0.00*	
		Intercept & Trend	-3.07	-56.69*	-3.41	0.11	0.00*	
	Spot	None	0.00	-46.13*	-1.94	0.68	0.00*	I(1)
		Intercept	-1.39	-46.13*	-2.86	0.59	0.00*	
		Intercept & Trend	-2.70	-46.12*	-3.41	0.24	0.00*	
Castor seed	Futures	None	-0.25	-48.41*	-1.94	0.59	0.00*	I(1)
		Intercept	-1.31	-48.41*	-2.86	0.63	0.00*	
		Intercept & Trend	-1.70	-48.40*	-3.41	0.75	0.00*	
	Spot	None	-0.07	-37.86*	-1.94	0.66	0.00*	I(1)
		Intercept	-1.20	-37.86*	-2.86	0.68	0.00*	
		Intercept & Trend	-1.52	-37.86*	-3.41	0.82	0.00*	
Guar seed	Futures	None	-2.30*	-19.79*	-1.94	0.02*	0.00*	I(0)
		Intercept	-3.82*	-19.79*	-2.86	0.00*	0.00*	
		Intercept & Trend	-4.34*	-19.79*	-3.41	0.00*	0.00*	
	Spot	None	-2.61*	-20.14*	-1.94	0.00*	0.00*	I(0)
		Intercept	-4.25*	-20.14*	-2.86	0.00*	0.00*	
		Intercept & Trend	-4.89*	-20.14*	-3.41	0.00*	0.00*	

Note: L: Level; F.D: First Difference; #: MacKinnon (1996) one-sided p-values. Null Hypothesis (H_0) of ADF test is that the series has unit root. * denotes significance at 5 per cent level and hence rejection of the null hypothesis. Absolute values are considered while comparing test statistics and critical values.